



Identification of Senior High School Students' Problem-Solving Skill on Static Electricity Based on Gender

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Abstract

This research aimed to identify differences in problem solving skill between male and female students. The research subjects were 50 students (21 male and 29 female) who were taken by random sampling technique from two high schools in Malang. The research instrument was adapted from problem solving instruments of Maries & Singh (2018). The data was analyzed by statistic descriptive and Kruskal Wallis test (p -value < 0.05). The results showed that overall, there was no significant difference between male and female students (p -value > 0.05). However male students performed better than female students on preparing the action (p -value < 0.05). The results of this research can be a consideration and input for practitioners of education to improve the quality of education, especially in Indonesia.

Keywords: Gender; Problem Solving Skill; Static Electricity

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INTRODUCTION

Problem solving is one of the important skills that Indonesian human resources need to have in facing the challenges of the 21st Century. In the 21st century, science, technology and communication are developing rapidly causing various problems. Thus, skill to solve problems quickly and precisely is needed to be able to continue to adapt to rapid development. Various components in education also need to be directed to help students in developing this skill, especially in learning curricula, including learning physics. The development of students' problem solving skill is one of the main goals in physics education

(Maloney, O'Kuma, & Hieggelke, 2001; Yulindar, Setiawan, & Liliawati, 2018).

Students' general problem solving skill such as analyzing as well as resolving problems and examining solutions that have been obtained are very effective and can improve students' performance (Gok, 2010). Problem solving skill is very important for students, but in reality in the field of physics, students experience difficulties in solving physics problem (Angell & Isnes, 2004). In Indonesia, students' problem solving skill is still relatively low (Azizah, Yuliati, & Latifah, 2015; Prihartanti, Yuliati, & Wisodo, 2017). Many studies on problem solving skill have been conducted, but one of the



problems that needs further research is the role of problem solving to study physics material (Maloney et al., 2001).

The identification of difficulties on static electricity showed that students need to improve their problem solving skill to help them develop their understanding. Maloney et al. (2001) reported that students experienced difficulties in solving static electricity problems related to force, field, work and electric potential. Students have misconception in electricity concepts (Bilal & Erol, 2009). Planinic (2014) found that students had difficulty in almost all static electricity matter except the force and electric charge. Maries and Singh (2018) found that students had difficulty in solving problems about electrical and potential energy in static electricity matter. These studies previously described the increase in students' static electricity difficulties. However, only few researches reported about problem solving skill students on static electricity.

Gender contributed the differences in encrypting memories, sensing emotions, identifying faces, solving problems, and making decisions (Ruigrok, Salimi-Khorshidi, Lai, Baron-Cohen, Lombardo, Tait, & Suckling, 2014; Speck, Ernst, Braun, Koch, Miller, & Chang., 2000; Weiss, Ragland, Bresinger, Bilker, Deisenhammer, & Delazer, 2006; Xin, Zhang, Tang, & Yang, 2019). Men's brain is not the same as women's brain (Ruigrok et al., 2014). Recently, it had been reported that human cognitive functions were influenced by gender (Cahill, 2006). This research was conducted to investigate the differences in problem solving skill between male and female students in learning physics, namely static electricity material. In addition, this research can be a useful picture for teachers and students to jointly develop problem solving skill.

METHOD

This research was a survey with a descriptive approach to identify students' problem-solving skill in the 2018/2019 school year. The type of data was quantitative data obtained from the results of the problem-solving test. The subjects of this research were 50 students consisting of 21 male and 29 female students of grade XII MIPA and were selected by random sampling technique from two schools in Malang, Indonesia, SMAN 3 Malang and SMAN 4 Malang. Those schools were selected since they used learning methods that were not much different so that the data obtained were expected to be homogeneous.

The instrument used in this research was a problem solving skill test adapted from Maries & Singh (2018) consisting of three questions on static electricity material. The questions presented as followed:

Question 1:

Look at Figure 1.

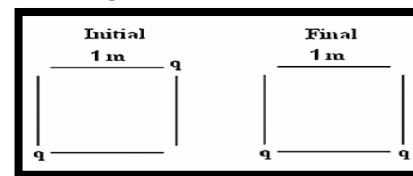


Figure 1 Initial and Final Position Q

Two identical point charges are initially fixed to diagonally opposite corners of a square that is 1 m on a side. Each of the two charges q is 3 C. How much work is done by the electric force if one of the charges is moved from its initial position to an empty corner of the square? ($k = 9 \times 10^9 \text{ Nm}^2/\text{C}^2$)

Question 2:

Look at Figure 2.

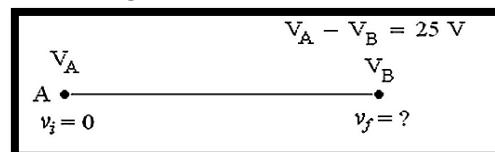


Figure 2 The Diagram That Describe Situation in Point A and B

A particle with mass 10^{-5} kg and a positive charge q of 3 C is released from rest from point A in a uniform electric field. When the particle arrives at point B, its electrical potential is 25 V lower than the potential at A. Assuming the only force acting on the particle is the electrostatic force, find the speed of the particle when it arrives at point B.

Question 3:

A particle of mass 10^{-4} kg and charge $q_1 = 1 \mu\text{C}$ is shot at a speed of 10 m/s directly towards another particle with charge $q_2 = 1 \mu\text{C}$ that is held fixed. If the initial distance between the two particles is 1 m, how close does the particle with charge q_1 get to q_2 ?

The data obtained was analyzed in every step which was used in problem solving process due to the CPS (Creative Problem Solving) model (Schunk, 2012) as follows: (1) understanding the

problems, the direction of problem solving is obtained, (2) bringing up the ideas, namely by determining choices in problem solving, (3) preparing the actions, in this step students described the formula and entered the data that have been obtained from the question/problem into the formula that has been determined in the previous step and performed mathematical calculations to get the answer.

The data obtained were presented in the form of descriptive statistics and were categorized into very good, good, fair, insufficient, and strongly insufficient. Kruskal wallis test was used and the $p\text{-value} < 0.05$ was considered a significant difference.

RESULT AND DISCUSSION

The result of the descriptive statistic of male and female students' problem-solving skill is presented in Table 1.

Table 1. Descriptive Statistic of Students' Problem-Solving Skill Based on Gender.

	Min	Max	Mean	Std. Deviation	Category
Understanding the problems					
Male students'	33	100	87.24	21.085	Very good
Female students'	33	100	94.28	15.591	Very good
Bringing up the ideas					
Male students'	0	100	76.19	31.943	Good
Female students'	0	100	66.76	26.816	Good
Prepare action the step					
Male students'	0	94	55.38	28.280	Fair
Female students'	0	100	33.53	21.808	Insufficient

Both male and female students' were very good in understanding the problems and were good in bringing up the ideas. Davita & Pujiastuti (2020) also found that the ability of male and female students' in understanding problems and making problem-solving plans were in the high category. From kurskall wallis test, it was obtained that there was no significant difference between male and female students in understanding the problem and in bringing up the ideas ($p\text{-value} > 0.05$).

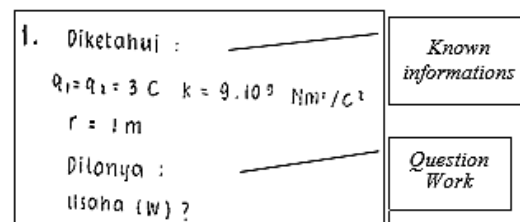


Figure 3 Understanding The Problem

A sample of the students' work that showed the step of understanding the problems in question 1 is presented in Figure 3. Student could collect the relevant information based on the

question or problems they faced, e.g electrical charge (q), the distance between two electrical charge (r), and the variable that they should look for.

Jawab : $F = k \frac{q_1 q_2}{r^2} \quad W = F \cdot s$ $= 9 \cdot 10^9 \frac{3 \cdot 3}{1^2} = 81 \cdot 10^9 \text{ Joule}$ $= 81 \cdot 10^9 \text{ N}$	Answer
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Figure 4 Bringing Up The Ideas

A sample of the students' work that showed the step of bringing up the ideas is presented in Figure 4. Student could determine the concepts or formulas that were suitable to get the answer of the question. As in figure 4, student wrote the formula of electrical force and formula of work that is done by the electric force.

On Table 1, male students gained 28.280 of average score (fair category) in preparing the action, while female students only gained 21.808 (insufficient category). Students had difficulty applying the formula or lacked the necessary mathematical ability in solving physics problems. This is similar to the findings of Azizah et al., (2015); Yulindar et al., (2018), in which students experienced difficulties after understanding and describing problems, namely when planning problem solving, carrying out problem solving, and evaluating the results obtained.

From kurskall wallis test, it was obtained that $p\text{-value} < 0.05$ or there was significant difference between male and female students in preparing the action. Hence, male students performed better than female students in preparing the action. The difference between male and

female students' in preparing the action can be seen in Figure 5 and 6.

$$E_{p1} + E_{k1} = E_{p2} + E_{k2}$$

$$k \frac{q_1 q_2}{r_1} + \frac{1}{2} m v_1^2 = k \frac{q_1 q_2}{r_2} + \frac{1}{2} m v_2^2$$

$$k \frac{q_1 q_2}{r_1} + \frac{1}{2} m v_1^2 = k \frac{q_1 q_2}{r_2} + 0$$

$$9 \cdot 10^9 \cdot \frac{10^{-6} \cdot 10^{-6}}{1} + \frac{1}{2} \cdot 10^{-4} \cdot 10 = 9 \cdot 10^9 \cdot \frac{10^{-6} \cdot 10^{-6}}{r_2}$$

$$9 \cdot 10^{-7} + \frac{1}{2} \cdot 10^{-3} = \frac{9 \cdot 10^{-7}}{r_2}$$

$$r_2 = 2 \cdot 10^{-2}$$

Figure 5 Preparing The Actions (Male Students)

$$k \frac{q_1 q_2}{r_1} + \frac{1}{2} m v_1^2 = k \frac{q_1 q_2}{r_2} + \frac{1}{2} m v_2^2$$

$$9 \cdot 10^9 \cdot \frac{10^{-6} \cdot 10^{-6}}{1} + \frac{1}{2} \cdot 10^{-4} \cdot 10 = 9 \cdot 10^9 \cdot \frac{10^{-6} \cdot 10^{-6}}{r_2} + \frac{1}{2} \cdot 10^{-4} \cdot 10$$

Figure 6 Preparing The Actions (Female Students)

Figure 5 and 6 show that male students performed better in using mathematical ability than female students. These findings differ from the results reported by Davita & Pujiastuti (2020) that the mathematical problem solving ability of female students was better than male students in carrying out the plan, female students gained 84 in average score (high category) while male students only gained 61 (fair category). Anggraeni & Herdiman (2018) found that in solving problems with a mathematical model, students tended to guess and operate mathematically without understanding the correct concept. Errors and inaccuracies are also often found when students do calculations.

The result of the male and female students' overall problem-solving skill is presented in Table 2.

Table 2. Descriptive Statistic of Students' Problem Solving-Skill Based on Gender.

	Min	Max	Mean	Std. Deviation	Category
Problem solving skill					
Male students	22	98	72.93	22.144	Good
Female students	22	100	67.57	15.512	Good

Overall, male students gained 72,93 (good category) and female students gained 67,57 (good category) on average score. Based on this statistic descriptive, male students performed better than female students. Zhu (2007) reported that males performed better on mathematics problem solving than females, based on many literature. This is similar to Nur & Palobo (2018) who found that male students' problem solving were in fair category, while female students' problem solving as the subjects in field dependent (FD) were in insufficient category. However, these findings differ from the results reported by Davita & Pujiastuti (2020) that male students' gained 74,57 and female students' gained 80,12 on average score, or female students' performed better than male students'.

From kurskall wallis test, it was obtained that $p\text{-value} > 0.05$ or there was no significant difference between male and female students' in overall problem solving. Both male and female students' problem-solving skill were good. Students who had cognitive strategy in field independent category had good problem solving. Nur & Palobo (2018) also found that both male and female students' in overall problem solving were in good category. Webb (1984) reported that females and males had equal achievement in groups of learning. On the other study, Asterhan (2018) found that there was no confidence and knowledge perceptions correlations with gender. The result of the students' problem-solving skill is presented in Table 3.

Table 3 Descriptive Statistic of Students' Problem-Solving Skill

	Min	Max	Mean	Std. Deviation	Category
Understanding the problems	33	100	91.32	18.239	Very good
Bringing up the ideas	0	100	70.72	29.146	Good
Prepare action the step	0	100	47.52	25.374	Fair
Problem solving skill	22	100	69.82	18.569	Good

Based on Table 3, it can be seen that students could understand the problems very well, bring up the ideas well, and prepare the actions, including perform mathematical calculations to get the answer fairly. Students still experienced difficulty in preparing the action in solving problems so that further research is needed for observers and education practitioners to develop and nurture problem solving skill in students.

CONCLUSION

Fifty students consisted of 21 male and 29 female students in two schools in Malang, Indonesia, were given problem solving test about static electricity. There are three steps in problem solving process due to the CPS model (Schunk, 2012) namely understanding the problems, bringing up the ideas, and preparing the

actions. This research found that students could understand the problems very well, bring up the ideas well, and fairly prepare the actions, including perform mathematical calculations to get the answer. Overall, students' problem-solving skill were good. From Kurskall Wallis test, it was obtained that $p\text{-value} < 0.05$ or there was significant difference between male and female students' problem solving, where male students performed better than female students on preparing the action. However, there was no significant difference between male and female students' overall problem solving. Therefore, gender differences did not contribute to overall problem-solving skill among high school students in static electricity, but contributed only when students was preparing the action.

The results of this research can be a consideration and input for practitioners of education to improve the quality of education, especially in Indonesia. In addition, this research can be a useful picture for teachers and students to jointly develop problem solving skill. Limitations in the research include: 1) the low number of subjects in this research resulted in difficulty to generalize the findings, 2) the low number of questions in the instrument that was used. Further research is needed using more number of subjects and questions in the instrument.

REFERENCE

- Angell, C., & Isnes, A. (2004). Physics: Frightful, but fun. Pupils' and teachers' views of physics and physics teaching. *Wiley InterScience*, 24. <https://doi.org/DOI10.1002/sce.10141>
- Anggraeni, R., & Herdman, I. (2018). Kemampuan Pemecahan Masalah Matematik Siswa SMP pada Materi Lingkaran Berbentuk Soal Kontekstual Ditinjau dari Gender. *Jurnal Numeracy*, Vol. 5, No1, 10.
- Asterhan, C. S. C. (2018). Exploring enablers and inhibitors of productive peer argumentation: The role of individual achievement goals and of gender. *Contemporary Educational Psychology*, 54, 66–78. <https://doi.org/10.1016/j.cedpsych.2018.05.002>
- Azizah, R., Yuliati, L., & Latifah, E. (2015). The Physic Problem Solving Difficulties on High School Student. *Jurnal Penelitian Fisika Dan Aplikasinya (JPFA)*, Vol 5, No 2. <http://journal.unesa.ac.id/index.php/jpfa>
- Bilal, E., & Erol, M. (2009). *Investigating Students' Conceptions of Some Electricity Concepts*. 3(2), 9.
- Cahill, L. (2006). Why sex matters for neuroscience. *Nature Reviews Neuroscience*, 7(6), 477–484. <https://doi.org/10.1038/nrn1909>
- Davita, P. W. C., & Pujiastuti, H. (2020). Analisis Kemampuan Pemecahan Masalah Matematika Ditinjau Dari Gender. *Kreano, Jurnal Matematika Kreatif-Inovatif*, 11(1), 110–117. <https://doi.org/10.15294/kreano.v11i1.23601>
- Gok, T. (2010). *The General Assessment of Problem Solving Processes and Metacognition in Physics Education*. 13.
- Maloney, D. P., O'Kuma, T. L., & Hieggelke, C. J. (2001). Surveying students' conceptual knowledge of electricity and magnetism. *Phys. Educ. Res.*, 69(7), 13.
- Maries, A., & Singh, C. (2018). Case of two electrostatics problems: Can providing a diagram adversely impact introductory physics students' problem solving performance? *The American Physical Society*, 14(010114). <https://doi.org/DOI:10.1103/PhysRevPhysEducRes.14.010114>
- Nur, A. S., & Palobo, M. (2018). Profil Kemampuan Pemecahan Masalah Matematika Siswa Ditinjau dari Perbedaan Gaya Kognitif dan Gender. *Jurnal Matematika Kreatif-Inovatif*, 2, 139–148.
- Planinic, M. (2014). Assessment of difficulties of some conceptual areas from electricity and magnetism using the Conceptual Survey of Electricity and Magnetism. *Am. J. Phys.*, 74(12), 7.
- Prihartanti, D., Yuliati, L., & Wisodo, H. (2017). Kemampuan Pemecahan Masalah Siswa pada Konsep Impuls, Momentum, dan Teorema Impuls Momentum. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, Vol. 2 No. 8, 1149–1159.
- Ruigrok, A. N. V., Salimi-Khorshidi, G., Lai, M.-C., Baron-Cohen, S., Lombardo, M. V., Tait, R. J., & Suckling, J. (2014). A meta-analysis of sex differences in human brain

- structure. *Neuroscience & Biobehavioral Reviews*, 39, 34–50. <https://doi.org/10.1016/j.neubiorev.2013.12.004>
- Schunk, D. H. (2012). *Learning theories: An educational perspective* (6th ed). Pearson.
- Speck, O., Ernst, T., Braun, J., Koch, C., Miller, E., & Chang, L. (2000). Gender differences in the functional organization of the brain for working memory: *NeuroReport*, 11(11), 2581–2585. <https://doi.org/10.1097/00001756-200008030-00046>
- Webb, N. M. (1984). Sex differences in interaction and achievement in cooperative small groups. *Journal of Educational Psychology*, 76(1), 33–44. <https://doi.org/10.1037/0022-0663.76.1.33>
- Weiss, E. M., Ragland, J. D., Brensinger, C. M., Bilker, W. B., Deisenhammer, E. A., & Delazer, M. (2006). Sex differences in clustering and switching in verbal fluency tasks. *Journal of the International Neuropsychological Society*, 12(04). <https://doi.org/10.1017/S1355617706060656>
- Xin, J., Zhang, Y., Tang, Y., & Yang, Y. (2019). Brain Differences Between Men and Women: Evidence From Deep Learning. *Frontiers in Neuroscience*, 13. <https://doi.org/doi:10.3389/fnins.2019.00185>
- Yulindar, A., Setiawan, A., & Liliawati, W. (2018). Enhancement of problem solving ability of high school students through learning with real engagement in active problem solving (REAPS) model on the concept of heat transfer. *IOP Publishing*. <https://doi.org/doi:10.1088/1742-6596/1013/1/012052>
- Zhu, Z. (2007). Gender Differences in Mathematical Problem Solving Patterns: A Review of Literature. *International Education Journal*, 8(2), 187–203.